

## PATENT ABSTRACTS OF JAPAN

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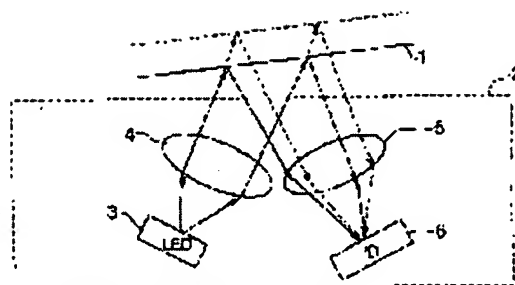
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## (54) TILT DETECTOR

## (57)Abstract:

PROBLEM TO BE SOLVED: To provide a tilt detector capable of detecting, with high precision, the inclination of the recording face of an optical disk.

SOLUTION: The tilt detector 2 for detecting the tilt of the recording face of an optical disk 1 is equipped with a light emitting means 3 for emitting a light beam to irradiate the recording face of the optical disk 1, a collimator lens 4 that parallelizes the light beam emitted by this light emitting means 3 and that emits this parallelized light beam to the recording face of the optical disk 1, a condensing lens 5 for converging the reflection light which is created by reflecting the parallelized light beam from the collimator lens 4 by the recording face of the optical disk 1, and a light receiving means 6 that receives the light beam converged by this condensing lens 5 with the light receiving plane divided into a plurality of areas and detects the center of gravity position in the intensity of the light beam received.



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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the inclination detection equipment which detects an inclination (this inclination is only hereafter called a "inclination") with the optical axis of the light beam irradiated for the purpose, such as reading of the information recorded on the recording surface of an optical disk by this recording surface, from the recording surface of an optical disk, and an optical pickup in an optical disk drive.

[0002]

[Description of the Prior Art] It has come to be required in connection with the densification of an optical disk that the precision of an optical pickup should be raised. Especially, exact perpendicularity with the optical axis of an objective lens prepared in the recording surface of an optical disk, the optical axis, i.e., the optical pickup, of a light beam irradiated for the purpose, such as reading of the information recorded on this recording surface, has come to be required from the recording surface of an optical disk, and an optical pickup.

[0003] On the other hand in connection with the densification of an optical disk, NA of the objective lens prepared in the optical pickup becomes large, and the wavelength of the light emitted from an optical pickup is becoming short. For this reason, the comatic aberration generated with the inclination of the recording surface of an optical disk and the optical axis of the light beam emitted from an optical pickup is becoming remarkably large, and the need of detecting the amount of inclinations (for example, include angle) has been increasing.

[0004] Since the aberration for offsetting an inclination must be generated by the liquid crystal device when [ which inclines and amends an inclination using a liquid crystal device based on an amount ] detected especially, it is necessary to detect the exact amount of inclinations (for example, include angle).

[0005] Conventionally, there was inclination detection equipment 102 as shown in drawing 9 as equipment which detects the amount of inclinations (for example, include angle). This inclination detection equipment 102 is attached and used for the optical pickup which emits the light beam for read-out of the information which was mentioned above, and which was recorded on the recording surface of an optical disk 101 etc. Apart from the light beam which an optical pickup emits, the emission light which a light emitting diode (LED) 103 emits is irradiated by the recording surface of an optical disk 101. The emission luminous intensity which light emitting diode (LED) 103 emits is carrying out Gaussian distribution. The return light of the light irradiated by the recording surface of an optical disk 101 is received with a photodiode (PD) 106. A photodiode (PD) 106 can detect the center-of-gravity location of the luminous intensity, which received light.

[0006] If the recording surface of an optical disk 1 inclines like the broken line a in drawing, the center-of-gravity location of the luminous intensity received in respect of light-receiving of PD106 will move. Migration of this center-of-gravity location is detected by PD106, and the amount of inclinations is detected.

[0007]

[Problem(s) to be Solved by the Invention] However, there are the following problems in above equipment. That is, although the center-of-gravity location of the luminous intensity received by the inclination in respect of light-receiving of PD106 moves with above equipment, by field blurring of an optical disk 101 etc., also when the distance from inclination detection equipment 102 to the recording surface of an optical disk 101 is changed, a center-of-gravity location moves, the value of the amount of inclinations detected changes and there is a problem that the highly precise amount of inclinations is undetectable, for example.

[0008] This problem is explained with reference to drawing 9 . If the recording surface of an optical disk 101 inclines like a broken line a, the center-of-gravity location of the light on the light-receiving side of PD106 will be moved in the direction which separates from LED103. On the other hand, even if the recording surface of an optical disk 101 keeps

away from the luminescence side of LED103, and the light-receiving side of PD106 like a broken line b, the center-of-gravity location of the light on the light-receiving side of PD106 is moved in the direction which separates from LED103.

[0009] This invention was made in order to solve the above-mentioned problem, and it offers the inclination detection equipment which can detect the highly precise amount of inclinations.

[0010]

[Means for Solving the Problem] In the inclination detection equipment with which invention according to claim 1 detects the inclination of the recording surface of an optical disk The luminescence means which emits the light for irradiating the recording surface of said optical disk, and the collimator lens which makes parallel light light which this luminescence means emitted, and irradiates this parallel light at the recording surface of said optical disk, The condenser lens with which the parallel light irradiated by the recording surface of said optical disk from this collimator lens condenses the reflected light reflected by the recording surface of said optical disk, It is inclination detection equipment characterized by having a light-receiving means to receive the light which this condenser lens condensed in respect of light-receiving currently divided into two or more fields, and to detect the center-of-gravity location of the luminous intensity which received light.

[0011] It is inclination detection equipment according to claim 1 characterized by constituting invention according to claim 2 with the light emitting/receiving lens with said same collimator lens and condenser lens.

[0012] Said luminescence means and light-receiving means of invention according to claim 3 are inclination detection equipment according to claim 2 characterized by being arranged on both sides of the optical axis of said light emitting/receiving lens in the symmetric position. Said luminescence means and light-receiving means of invention according to claim 4 are detection equipment whenever [ according to claim 2 angle-of-inclination / which is characterized by being arranged on the optical axis of said light emitting/receiving lens ]. Invention according to claim 5 is inclination detection equipment according to claim 2 characterized by said light emitting/receiving lens having two center of curvatures of a lens.

[0013]

[Embodiment of the Invention] The configuration of the inclination detection equipment in the 1st operation gestalt of this invention is explained with reference to drawing 1 . A sign 1 is an optical disk covered over the inclination detection equipment of this invention. A sign 2 is inclination detection equipment for detecting the amount of inclinations with the optical axis of the light beam irradiated from the optical pickup which is not illustrated for read-out of the information recorded on the recording surface of said optical disk 1 and the recording surface of this optical disk 1 by this recording surface etc. This inclination detection equipment 2 is being fixed on said optical pickup.

[0014] Inclination detection equipment 2 contains light emitting diode (LED) 3, the collimator lens 4, the condenser lens 5, and the photodiode (PD) 6. A light emitting diode (LED) 3 emits the emission light for irradiating the recording surface of an optical disk 1. This emission luminous-intensity distribution is Gaussian distribution. A collimator lens 4 irradiates the light which made parallel light emission light which said light emitting diode (LED) 3 emits, and was made into parallel light at the recording surface of said optical disk 1.

[0015] It is reflected by the recording surface of an optical disk 1, and incidence of the irradiated parallel light is carried out to a condenser lens 5. Since the light irradiated by the recording surface of an optical disk 1 is parallel light, the reflected light also turns into parallel light. A condenser lens 5 makes the reflected light which is parallel light condense on the light-receiving side of a photodiode (PD) 6. A photodiode (PD) 6 detects the center-of-gravity location of the condensed luminous intensity.

[0016] Drawing 2 is drawing which looked at the light-receiving side of the above-mentioned photodiode (PD) 6 from the top. The light-receiving side of a photodiode (PD) 6 is made into radial (the direction of RAD), i.e., the radial direction, of an optical disk 1 2 \*\*\*\*s, is carried out in the tangential direction (direction of TAN), i.e., tangential direction, of a periphery of an optical disk 1 2 \*\*\*\*s, and is divided into four fields 6A, 6B, 6C, and 6D in total. Each fields 6A, 6B, 6C, and 6D output the quantity of light signals A, B, C, and D according to the quantity of light which each field received.

[0017] Next, actuation of this operation gestalt is explained. If the recording surface of an optical disk 1 inclines, the center-of-gravity location of the luminous intensity on the light-receiving side of PD6 will move. Migration of this center-of-gravity location is detected by the quantity of light signals A, B, C, and D outputted from the fields 6A, 6B, 6C, and 6D where PD6 was quadrisedected. That is, the quantity of light signals A, B, C, and D are sent to the operation means which is not illustrated, the operation shown in the following formula is performed, and the amount of inclinations of a radial direction and the amount of inclinations of the tangential direction are computed.

The amount of inclinations of a radial direction = (A+B)-(C+D)

The amount of inclinations of the tangential direction =  $(A+D)-(B+C)$

[0018] However, even if it changes the distance from inclination detection equipment 2 to the recording surface of an optical disk 1, the center-of-gravity location of the luminous intensity on the light-receiving side of PD6 is not moved, therefore the quantity of light signals A, B, C, and D do not change, either. Therefore, by field blurring of an optical disk 1 etc., even if it changes the distance from inclination detection equipment 2 to the recording surface of an optical disk 1, an error is not in the amount of inclinations detected.

[0019] This principle is explained with reference to drawing 3. Fluctuation of the distance from inclination detection equipment 2 to the recording surface of an optical disk 1 changes the height from optical-axis 5a of a condenser lens 5 of the parallel light which carries out incidence to a condenser lens 5. For example, it changes from height h1 like h2. However, even if the height from optical-axis 5a of parallel light changes, the condensing location on the light-receiving side of PD6 does not change.

[0020] Next, the inclination detection equipment in the 2nd operation gestalt of this invention is explained with reference to drawing 4. The single light emitting/receiving lens 7 used for both floodlighting and light-receiving is formed instead of the condenser lens 5, i.e., lens for light-receiving, the collimator lens 4, i.e., the lens for floodlighting, in said 1st operation gestalt, at this operation gestalt. Moreover, LED3 and PD6 are arranged in the location [ a / of the light emitting/receiving lens 7 / optical-axis 7 ] shifted. LED3 and PD6 are arranged in the symmetric position at the detail on both sides of optical-axis 7a of the light emitting/receiving lens 7.

[0021] Since LED3 emits light from the location [ a / of the light emitting/receiving lens 7 / optical-axis 7 ] shifted, the parallel light irradiated from the light emitting/receiving lens 7 to the recording surface of an optical disk 1 does not become parallel to optical-axis 7a of the light emitting/receiving lens 7, but has an include angle to optical-axis 7a. Light with this include angle is reflected by the recording surface of a disk 1, and the reflected light which had an include angle too is returned to the light emitting/receiving lens 7. It is condensed with the light emitting/receiving lens 7, and incidence of the parallel light which had an include angle to optical-axis 7a returned to the light emitting/receiving lens 7 is carried out to PD6 which is in a symmetric position on both sides of LED3 and optical-axis 7a. Since the actuation by fluctuation of the inclination of a disk 1 or distance is the same as that of the 1st operation gestalt, explanation is omitted.

[0022] Next, the 3rd operation gestalt of this invention is explained with reference to drawing 5. The lens with which two center of curvatures of a lens are is used for this operation gestalt as a light emitting/receiving lens 8. Drawing 6 is drawing which looked at this light emitting/receiving lens 8 from the top face. In said 2nd operation gestalt, if spacing of LED3 and PD6 is enlarged, the thickness of the light emitting/receiving lens 7 will become large, and inclination detection equipment 2 will be enlarged. Thickness of a lens can be made small if the \*\*\*\* lens 8 with two center of curvatures of a lens shown with this operation gestalt is used at this time.

[0023] Next, the 4th operation gestalt of this invention is explained with reference to drawing 7. In this operation gestalt, LED3 is arranged on the optical axis of the light emitting/receiving lens 9. Furthermore, between the light emitting/receiving lens 9 and LED3, the beam splitter 10 is arranged and PD6 for light-receiving is arranged beside this beam splitter 10.

[0024] Actuation of this operation gestalt is explained. The emission light which LED3 emitted penetrates a beam splitter 10, with the light emitting/receiving lens 9, it considers as an parallel light parallel to the optical axis of this light emitting/receiving lens 9, and this parallel light is irradiated by the recording surface of an optical disk 1. It is reflected by this recording surface and the parallel light irradiated by the recording surface of an optical disk 1 returns the same optical path as the time of floodlighting. Incidence is again carried out to the light emitting/receiving lens 9, and it is condensed with this light emitting/receiving lens 9, and by the beam splitter 10, this reflected light can bend an optical axis 90 degrees, and carries out incidence to PD6. Since parallel light can be applied to the recording surface of an optical disk 1 and the reflected light from a recording surface can be received by PD6 by the above actuation, actuation with said 1-3rd operation gestalt and the same actuation are realizable for fluctuation of the inclination of a disk 1, or distance.

[0025] Next, the 5th operation gestalt of this invention is explained with reference to drawing 8. In this operation gestalt, LED3 is arranged at the core of PD6. If actuation of this operation gestalt is explained, emission light which LED3 emits will be made into parallel light with the light emitting/receiving lens 9, and this parallel light will be irradiated by the recording surface of an optical disk 1. Incidence is again carried out to the light emitting/receiving lens 9, it is condensed with this light emitting/receiving lens 9, and the reflected light from a recording surface is received by PD6. The actuation at the time of fluctuation of the inclination of a disk 1 or distance is the same as actuation with said 1-4th operation gestalt.

[0026]

[Effect of the Invention] According to this invention, since a detection value is not influenced by fluctuation of the distance of inclination detection equipment and the recording surface of an optical disk, it can extract only the amount of inclinations and becomes detectable [ the highly precise amount of inclinations ].

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[Translation done.]

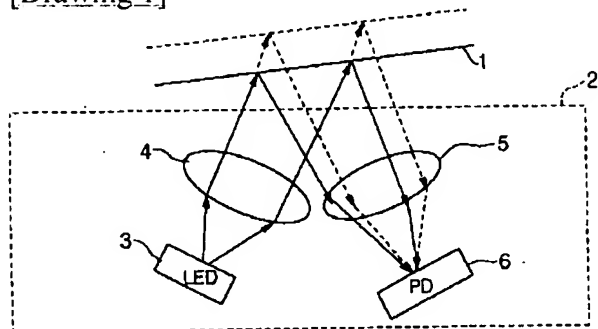
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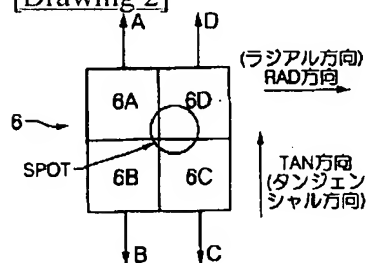
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## DRAWINGS

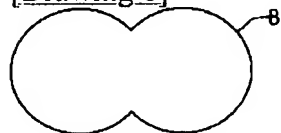
[Drawing 1]



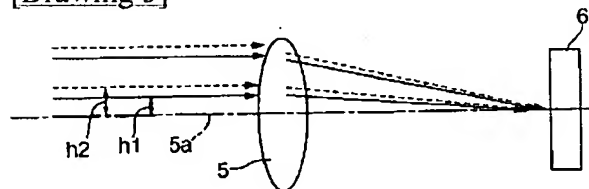
[Drawing 2]



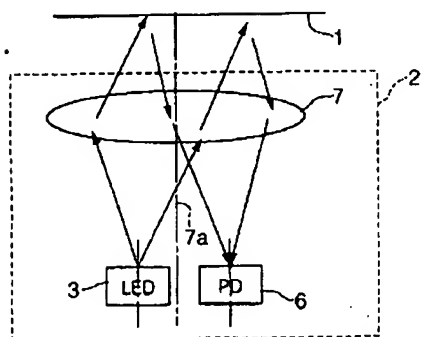
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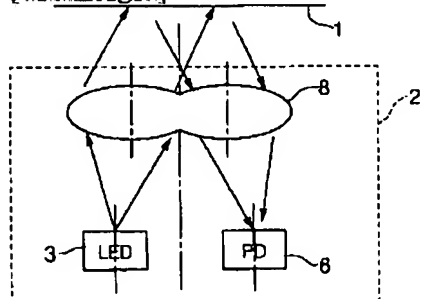
[Drawing 3]



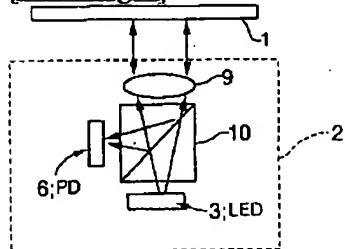
[Drawing 4]



[Drawing 5]

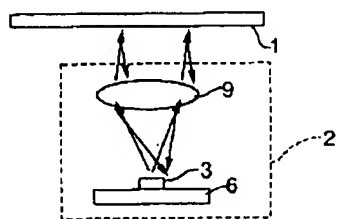


[Drawing 7]

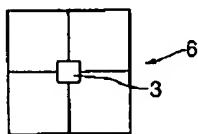


[Drawing 8]

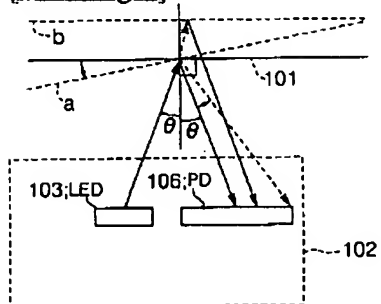
(a)



(b)



[Drawing 9]





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[Translation done.]